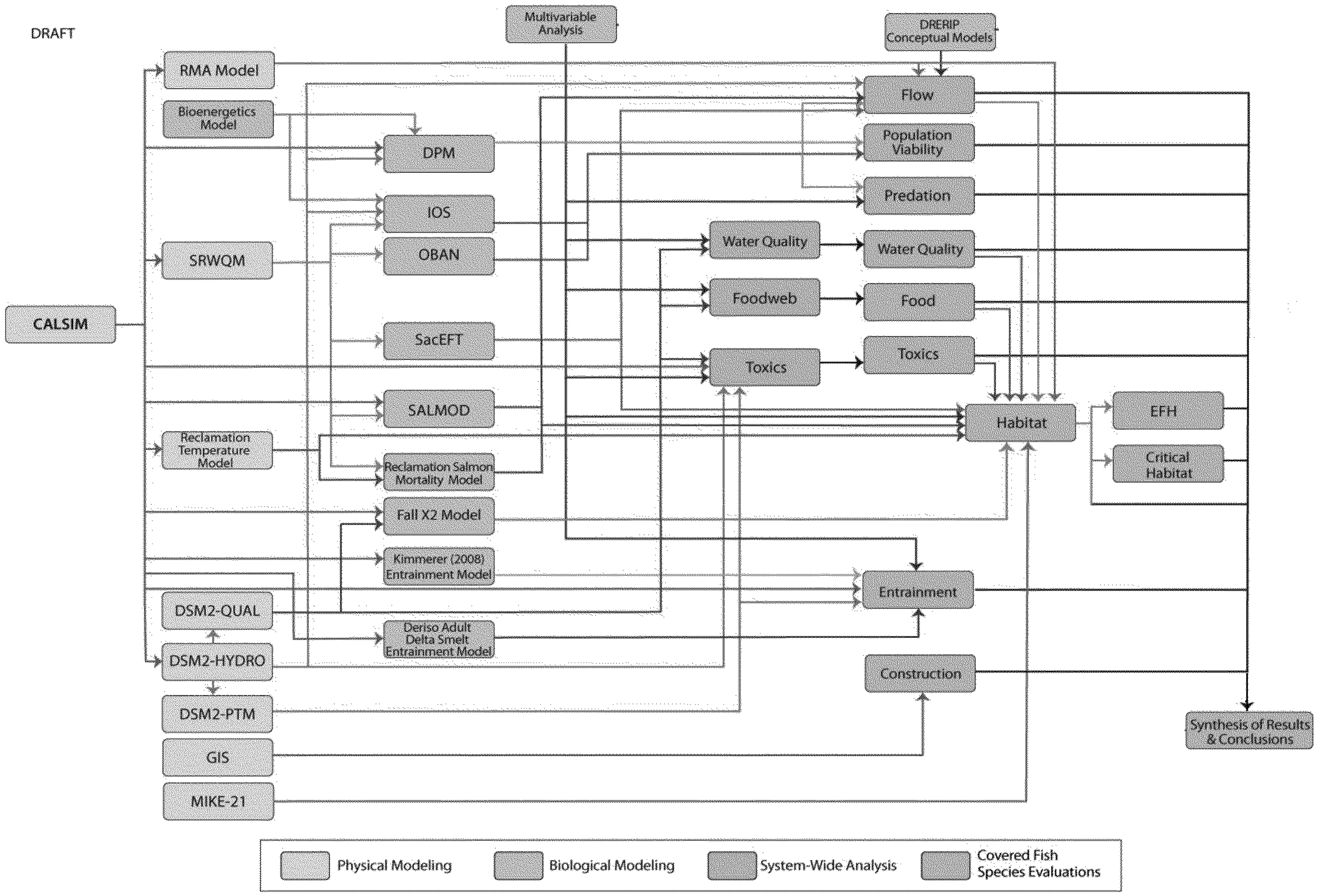
1) Why is there a thing called CalSim? (genesis/background)

   a) DWR and USBR had a need to quantify how much water could be put under long-term contracts for delivery to water users – to determine the "yield" of their projects given the prevailing constraints on the system's variable water supply. A monthly time step and coarse spatial representation of the system was adequate for this purpose. Around 2000, DWR and USBR decided to stop using separate pure simulation models (in which the specified combination of rules resulted in storages and flows for each month), so their staffs jointly developed "CalSim".

   b) The original intended model purpose and model use were in alignment. Now the model's use has been stretched/twisted to help inform different questions/problems as can be seen from the early BDCP flowchart below. There are significant spatial and temporal scaling issues.



2) What is it?

   a) <u>Monthly</u> <u>water-volume</u> <u>accounting</u> <u>model</u> – a collection of computer files comprised of data and logic which reflect/house hundreds of assumptions that simulates up to 82 years of major water operations, primarily in California's Central Valley.

   b) The model is actually an optimization model, not a simulation model, so the user specifies what's desirable and what's required and then the solver figures out what the "best" set of reservoir releases are.

c) The model is a network of computation nodes (where space is lumped) and dimensionless connectors.
   Example: A month of surface runoff along a river reach is treated as entirely entering the river at the downstream point, i.e., limited spatial resolution. The modeled channel connecting the upstream point and the downstream point (connector or arc or link) has no depth, width, roughness, etc, so there is no velocity, averaged or otherwise, i.e., it is NOT a hydraulic model. (Connectors do typically have inputted maximum flow constraints.)

d) "It" is CalSimII, currently the most widely used model of its kind for long term planning studies that involve the CVP and SWP. CalLite is a simpler, faster version with a different GUI for use as a screening tool. CalSim 3 is perpetually almost complete – it represents the same areal extent of the real world, still on a monthly basis, but with finer spatial resolution.

3) What does it attempt to represent temporally?

   a) Simulations (i.e., runs, scenarios, studies) usually cover the period from Water Year 1922 through Water Year 2003.

   b) Think of it as using the historical rainfall and snowmelt. These are represented via inflows and accretions in the model. The inflows and accretions are adjusted historical values taking into account the assumed level of development in the area in which the rainfall and snowmelt occurred. (hist => native veg => LOD)

4) Climate Change Representation (current climate, Early Long Term climate, Late Long Term climate)

   a) 30 year average conditions centered around 1985, 2025 and 2060

   b) Revised timing and magnitude of runoff from the mountains into the main reservoirs and rivers (e.g., monthly flow volume into Shasta Lake, Cottonwood Creek into the Sacramento River) which affects a few years' yeartype classification, runoff forecasts used in reservoir operations and allocation decisions, dates when temperature-based smelt OMR reqts offramp.

   c) Not revised FC diagrams (Folsom's taking forever to revise)

   d) Not changed land use, a.k.a. Level of Development (LOD)
      i) No change in the types of crops
      ii) No change in the relative acreages of various crops

   e) Not changed Ag or Urban water use efficiency

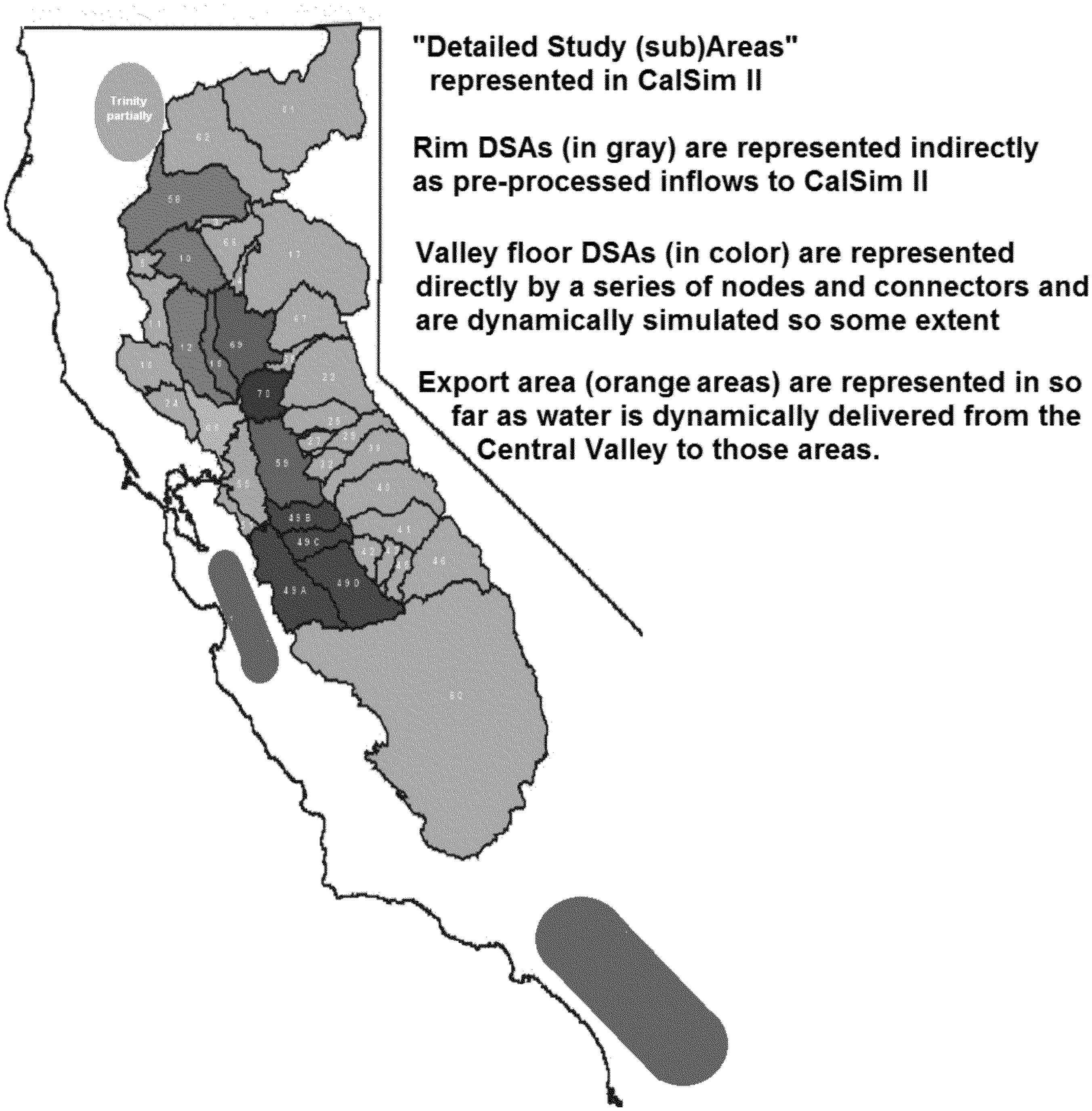
   f) Sea level at the Golden Gate Bridge – X, X+6" (15cm), X+18"(45cm) which affects ANN salinity-flow relationships.

5) What does it attempt to represent spatially?

   i) Sacramento Valley and the East side of the San Joaquin Valley – accretions/depletions, demands, surface water and groundwater use and return flows. These are often referred to collectively as "hydrology"

   ii) West side of the San Joaquin Valley – water deliveries based on fraction (0%-100%) of contract amounts allocated (and physical conveyance capacities) and return flows (primarily for EC calculations for Vernalis).

   iii) Export areas to the west and south that receive CVP and/or SWP water – water deliveries based on fraction (0%-100%) of contract amounts allocated (and physical conveyance capacities)



CalSimII studies use a static, snapshot of land use and infrastructure, i.e., NO (historical) buildup or coming on line of facilities.

6) What infrastructure is included?

a) Major Dams/Reservoirs –

Trinity	2447	TAF	(refill potential ~ I:S ~ **0.56**)
Lewiston	~10	TAF	(not represented as a reservoir)
Whiskeytown	240	TAF	
Shasta	4552	TAF	(refill potential ~ I:S ~ 1.31)
Keswick	24	TAF	
East Park	51	TAF	
Stony Gorge	50	TAF	
Black Butte	136	TAF	
Sites	-----	TAF	(Split into Local, SWP, CVP, EWA, WQ)
Oroville	3558	TAF	(refill potential ~ I:S ~ 1.27)
Thermalito	12	TAF	
Folsom	975	TAF	(refill potential ~ I:S ~ **2.75**)
Nimbus/Natoma	9	TAF	
New Bullards Bar + others	(large)	TAF	Yuba system pre-operated
Camp Far West + others	(smaller)	TAF	Bear system pre-operated
Los Vaqueros	(var)	TAF	
--			
Friant/Millerton	521	TAF	
Hidden/Hensley	90	TAF	(Fresno River)
Buchanan/Eastman	151	TAF	(Chowchilla River)
New Exchequer/McClure	1024	TAF	(refill potential ~ I:S ~ 0.98)
New Don Pedro	2030	TAF	(refill potential ~ I:S ~ 0.96)
Modesto	(small)	TAF	
Turlock	(small)	TAF	
New Melones	2420	TAF	(refill potential ~ I:S ~ **0.48**)
Tulloch	(small)	TAF	
Woodward	(small)	TAF	
Goodwin	~ 0	TAF	
New Hogan	325	TAF	
Pardee	210	TAF	(Mokelumne system pre-operated)
Camanche	438	TAF	(Mokelumne system pre-operated)
--			
Del Valle	32?		
CVP San Luis	972	TAF	
SWP San Luis	1067	TAF	
Kern Water Bank	800?	TAF	
Silverwood	75	TAF	
Perris	131	TAF	
Pyramid	171	TAF	
Castaic	324	TAF	
Diamond Valley (MET)	800	TAF	(not represented as a reservoir)

b) Major Canals/Aqueducts –

- Clear Creek Tunnel
- Spring Creek Tunnel
- Corning Canal
- Tehema Colusa Canal
- Glenn Colusa Canal
- Folsom South Canal
- North Bay Aqueduct
- Contra Costa Canal
- South Bay Aqueduct
- California Aqueduct including Coastal Branch
- Delta Mendota Canal

- Pacheco Tunnel (back side of SLR)
- Cross Valley Canal
- Madera Canal
- Friant-Kern Canal

c) Major Weirs and Gates:
- Moulton Weir
- Colusa Weir
- Tisdale Weir
- Fremont Weir
- Sacramento Weir
- Delta Cross Channel Gates
- Ag barriers and Head-of-Old-River barrier (reflected via alternative Q – EC equations)
- Montezuma Slough Gate (reflected via ANN from DSM2)

7) Parameters

a) WATER only! Surrogate quantities of water assumed sufficient to meet delta salinity standards, Vernalis salinity standards and dissolved oxygen on the Stanislaus, sometimes water temperature on Sacramento River below Keswick.

i) Delta salinity standards – An artificial neural network is used to relate flow to salinity.
ii) Vernalis water quality (EC only) – Regressions based on historical data are used.
iii) Stanislaus dissolved oxygen – Flat flow rates are assumed to meet D.O. (one set for normal yrs, one for crt yrs).
iv) Water temperatures below Keswick – Specific flow regimes have been tried, discontinued.

b) Physically, no salinity, no temperature, no dissolved oxygen, no contaminants otherwise.

8) Inputs

a) Physical descriptions – reservoir characteristics, channel capacities, connectivity between computation points

b) Regulatory descriptions – Minimum allowable instream flows, maximum allowed salinities, COA sharing, etc.

c) Hydrology –
i) Reservoir inflows
ii) Accretions/depletions below the rim dams (based on sub-basins as discussed above)
(1) Calculate historical local water supply
(2) Undo development to calculate pre-development local water supply
(3) Apply assumed development to calculate projected local water supply (acres of 10+ crop types, four land use types, etc.)
iii) Irrigation Efficiency, re-use, losses, minimum and maximum groundwater use

d) Demands - Demands are preprocessed, independent of CalSim-II and may vary according to the specified level of development (e.g. 2005, 2030) and according to hydrologic conditions. They are typically input into the model as a monthly time series. The model determines the surface water and groundwater deliveries that may or may not fully meet these demands.
i) Agricultural demands:
(1) In the Sacramento River Basin (including the Feather and American River basins), Eastside of the San Joaquin Basin and Delta, these demands are determined based on land use and vary by month and year according to hydrologic conditions. Land use-based demands are calculated using DWR's Consumptive Use (CU) model. The CU model simulates soil moisture conditions for 13 different crop types over the historical period. The demand for irrigation water is triggered when soil moisture falls below a specified minimum. The CU model calculates the crop consumptive use of applied water. The consumptive use is subsequently multiplied by water use efficiency factors to obtain a regional water requirement to be met from stream diversions or groundwater pumping. In CalSimII, non-recoverable losses are assumed to be 10 to 15 percent of the crop consumptive use of applied water. Non-recoverable loss factors are used to determine the portion of the supply that will return to the system as surface

return flow or as deep percolation to groundwater. Efficiency factors may vary by month and by year.

(2) Agricultural demands in the Delta are represented more simply as an overall mass balance between precipitation and crop evapotranspiration.

(3) On the westside of the San Joaquin Basin and all other export areas, CVP and SWP agricultural demands are simply based on contract amounts. CVP demands south of the Delta are assumed to be fixed at maximum contract amount and do not vary year to year. SWP agricultural demands in the San Joaquin Valley are usually assumed to be fixed at maximum contract amount.

ii) M&I demands:

(1) In the Sacramento River Basin (including the Feather and American River basins) and Eastside of the San Joaquin Basin, indoor urban water use is considered non-consumptive and is ignored by the model. Outdoor urban water use is treated as an irrigation demand and is combined with the agricultural demands. M&I diversions, although not entirely consumptive, can have a large influence on reservoir operations. However, both indoor and outdoor M&I surface water diversions have therefore been included in CalSimII for the American and Lower Sacramento River areas because they partially determine the operation of Folsom Lake. Outdoor urban demand is calculated by the CU model, with the irrigated area computed as a fixed fraction of the total urban area as measured by DWR in land use surveys.

(2) In all export areas, CVP and SWP M&I demands are based on contract amounts. CVP demands are assumed to equal contract amounts and do not vary. SWP demands are split into Metropolitan Water District of Southern California (MWDSC) and others. MWDSC demands are either set at full contract amounts or are determined through a process of iteration between CalSim-II and MWDSC's integrated resource planning simulation (IRPSIM) model, and vary from year to year. Other SWP M&I contractors' demands are fixed at their full contract amounts.

iii) Non-project demands:

(1) Demands are disaggregated in CalSimII into project demands and non-project demands. Project demands are subject to reduced water allocations based on CVP and SWP contract provisions, while non-project demands are satisfied from sources other than project storage and project conveyance facilities and are reduced as a function of water availability in the absence of project operations. For each Depletion Study Area (DSA), project demands are calculated as a fixed percentage of the total land use-based demand. The split between project and non-project demands was determined by comparing project acreage within each DSA to the total crop acreage within the DSA.

iv) Environmental Water demands:

(1) Environmental water requirements such as minimum reservoir storage requirements, minimum in-stream flows below dams and delta outflows and deliveries to national wildlife refuges, and wildlife management areas that are stipulated in current or assumed regulatory requirements and discretionary interagency agreements are included in the model.

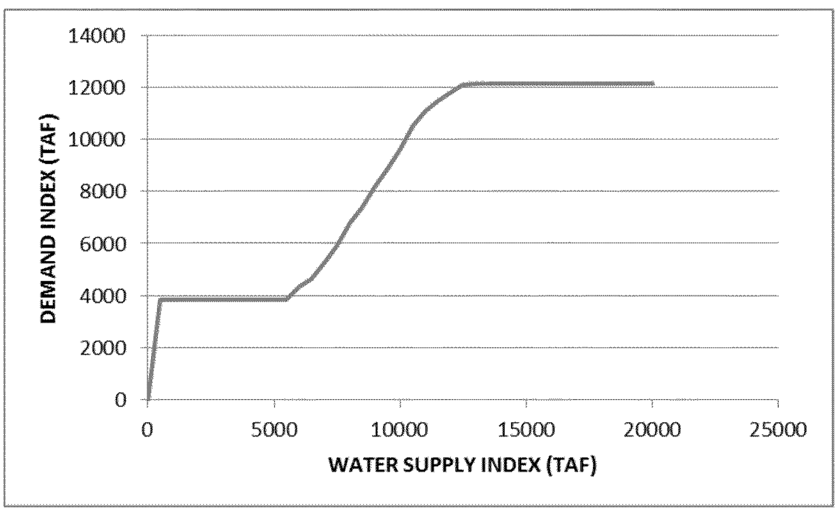
v) Contract amounts and allocations - In addition to the contract numbers below, when there is "excess" water and conveyance to move it, the SWP offers "Interruptible" = "Article 21" water and CVP offers "215" water. The model includes Article 21 water but not 215 water.

Table 1. Summary of SWP and CVP Contracts (TAF/Year)

Project	North Of Delta	South of Delta
CVP Contracts		
• Settlement/Exchange	2,194	840
• Ag Water Service	378	1,937
• M&I	557	164
• Refuges	189	281
• 215 (extra in wet times - rare)	?	variable
SWP Contracts		
• Feather River Service Area	796	0
• Agriculture	0	1,032
• M&I	114	3,024
• Article 21 (extra in wet times)	?	variable*

* Rate of diversion may be very high and duration of availability can be short lived.

The water allocation process must consider the various categories of water demands and the contractual amounts and deficiency criteria associated with each. These water demands may be categorized as follows: (1) Water Rights Settlement Agreements; (2) Municipal and Industrial Water Service Contracts; (3) Legislative Mandates; (4) Agricultural Water Service Contracts; and (5) Delivery Losses. CalSim-II uses allocation logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses pre-determined runoff forecast information, which incorporates uncertainty and standardized rule curves (i.e. Water Supply Index versus Demand Index Curve). The WSI-DI rule curves relate forecasted water supplies to deliverable "demand," and then splits the deliverable "demand" between water to be delivered and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta delivery levels are determined based on water supply parameters and operational constraints (export and conveyance capabilities).



9) Specific Representation of Section 7 No-Action Alternative at ELT

a) Upstream Criteria:

	Monthly maximum storage levels	
	Mar31 Daily flow regimes per 50% Exceedance April Forecast of yeartype (History note – 1964 River lost approx. 75% of its water, used to keep 120 - 340TAF, now 369 TAF – 815 TAF).	blocks of water released based on **perfectly forecasted** yeartype.
	constant at 240 TAF in summer and 206 TAF in winter.	match USBR targets

Whiskeytown	**NMFS 2009 BiOp RPA: <u>Action Suite 1.1 Clear Creek</u>**
	Objective: The proposed action includes a static flow regime (no greater than 200 cfs all year) and uncertainty as to the availability of b(2) water in the future pose significant risk to these species. The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. Although not all of the flow studies have been completed, NMFS believes these actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.
	<u>Action I.1.1. Spring Attraction Flows</u>
	Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.
	Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem. This may be done in conjunction with channel-maintenance flows (Action I.1.2).
	
	<u>Action 1.1.5. Thermal Stress Reduction</u>
	Objective: To reduce thermal stress to
		Oct-Apr and Jun, 277.4 cfs in May (200 cfs for 25 days + 600 cfs for 6 days), 85 cfs in Jul and Aug (estimated flow rate to maintain water temperatures) and 150 cfs (transitioning from summer temperature flow to 200 cfs by end of month) in Sep
		
		`Oct – 12.3 TAF`
		`Nov – 11.9 TAF`
		`Dec – 12.3 TAF`
		`Jan – 12.3 TAF`
		`Feb – 11.1 TAF`
		`Mar – 12.3 TAF`
		`Apr – 11.9 TAF`
		`May – 17.1 TAF`
		`Jun – 11.9 TAF`
		`Jul –  5.2 TAF`
		`Aug –  5.2 TAF`
		`Sep –  8.9 TAF`
		
		(unless Trinity storage drops below 600 TAF in which case releases may be reduced.)
		
		Action 1.1.5 Assumptions for CALSIM II Modeling Purposes Action: It is assumed that temperature operations can perform reasonably well with flows included in model.

	over-summering steelhead and spring-run during holding, spawning, and embryo incubation. **Action:** Reclamation shall manage Whiskeytown releases to meet a daily water temperature of: 1) 60°F at the Igo gage from June 1 through September 15; and 2) 56°F at the Igo gage from September 15 to October 31. (History note: CVPIA §3406(b)(1) or (b)(2) supplements 1960's MOU minimum of 50 cfs Jan1-Oct31, 100 cfs Nov1-Dec31).	
	Diagram (19??) – Variable daily maximum allowable storage based on antecedent inflows	of each simulated month (timeseries) **(Climate change should change this)**
	specifies performance measures targeting maintaining EOS at or greater than 2.2 MAF 87% of years (<u>over simplified</u>)	to infeasibility of solution.
Sacramento River below Keswick	for instantaneous rate of not less than 3250 cfs from Sep1 through Feb28. NMFS 2009 BiOp RPA Action Suite 1.2 has additional objectives related to water temperature management – See Dec2013 BDCP DEIS Appendix 5A's Section B.10	blocks of water are the least amount that may be released below Keswick. **NOT in model**
RPA was represented.		
5A's Section B.10 for how NMFS 2009 BiOp's RPA was represented.		
elevation and 11.5' elevation gates.	inundation in the Yolo Bypass, the 17.5 foot and the 11.5 foot elevation gates are assumed to be opened between December 1st and March 31st. This may extend to May 15th, depending on the hydrologic conditions and the measures to minimize land use and ecological conflicts in the bypass. The	gates are assumed opened Dec01-Apr30 in all years. As a simplification for modeling, the period of operation for the 11.5' gate is assumed to be Sep01-Jun30.

	gates are operated to limit maximum spill to 6,000 cfs until the Sacramento River stage reaches the existing Fremont Weir elevation. While desired inundation period is on the order of 30 to 45 days, gates are not managed to limit to this range, instead the duration of the event is governed by the Sacramento River flow conditions. To provide greater opportunity for the fish in the bypass to migrate upstream into the Sacramento River, the 11.5 foot elevation gate is assumed to be open for an extended period between September 15th and June 30th. The spills through the 11.5 ft elevation gate are limited to 100 cfs to support fish passage.	

b) Delta Criteria:

	Objectives for Fish and Wildlife Beneficial Uses) Minimum monthly average flow rate (CFS) WY type Time Period Value All Sep 3000 W,A,B,D Oct 4000 C Oct 3000 W,A,B,D Nov-Dec 4500 C Nov-Dec 3500	blocks of water are the least amount that must pass Rio Vista on the Sacramento River.
	Objectives for Fish and Wildlife Beneficial Uses) Minimum monthly average flow rate (CFS)* WY type† Time Period Value=f(X2) W,A Feb01-Apr14 2130/3420 B,D Feb01-Apr14 1420/2280 C Feb01-Apr14 710/1140 W Apr15-May15 7330/8620 A Apr15-May15 5730/7020 B Apr15-May15 4620/5480 D Apr15-May15 4020/4880 C Apr15-May15 3110/3540 W,A May16-Jun30 2130/3420 B,D May16-Jun30 1420/2280 C May16-Jun30 710/1140 Regarding Feb, Mar and Jun reqts, in drier years USBR submits a TUCP to relax the requirements. Regarding Apr01-May31 reqts: NMFS 2009 BiOp's RPA specified Phase I interim flows using NMI and assuming VAMP continued. It then specified Phase II (Action IV.2.1) flows based on WY type and the assumption SWRCB would effectuate releases from other tribs. Since neither is currently the case, year-to-year negotiations between USBR and the fish agencies strive to maintain a relatively stable flow during the period. USBR has opted to take the stance that NMFS 2009 BiOp's RPA requirements	blocks of water are the least amount that must pass Vernalis on the San Joaquin River for Feb, Mar, and Jun using perfect foresight of WY type. No flow requirements in model for Apr15-May15 at Vernalis.

	for Goodwin's releases satisfy their obligation. SWRCB doesn't agree, but no enforcement action has occurred. *VAMP used to replace Apr14-May15 † WY type is per 75% exceed forecast	
	Nov01-Jan31 close up to 45 days Feb01-May20 close May21-Jun15 close 14 days **NMFS 2009 BiOp RPA: <u>Action 4.1.2</u>** specifies for Oct01-Nov30 that if WQ per D1641 is okay and certain fish density thresholds are triggered, then the DCC shall be closed. For Dec1-14, certain combinations of meeting WQ and fish densities lead to opening or closing the DCC.	Sacramento River daily flow at Wilkins Slough exceeds 7,500 cfs. Using historical data (1945 through 2003, USGS gauge 11390500 "Sacramento River below Wilkins Slough near Grimes, CA"), a linear relationship was obtained between average monthly flow at Wilkins Slough and the number of days in the month when the flow exceeds 7,500 cfs. CalSim's preliminary monthly flow at Wilkins Slough and the linear relationship is used to determine the number of days of DCC closure. If those days of closure are estimated to cause WQ problems (discussed below) and the gates are left open, then South Delta exports are limited to a combined 2000 cfs. Trumping the above is WQ concerns. Using the CalSim's flow-salinity relationships for Rock Slough, current month's chloride level at Rock Slough is estimated assuming DCC closure per NMFS BO. The estimated chloride level is compared against the Rock Slough chloride standard (monthly average). If estimated chloride level exceeds the standard, the gate is modeled per D1641 schedule (for the entire month). For those days the D1641 schedule calls for the DCC to be open, South Delta exports are limited to a combined 2000 cfs, as stated above. For Dec15-May20: DCC is closed. For May21-Jun15: A fixed daily pattern is used.
Required Flow – NDOI = calculated	minimum values in cfs ranging from	blocks of water are the least amount

value that's sensitive to rainfall in Stockton.) Excluding Spring X2.	3000 cfs in All Septembers to 8000 cfs in Julys of Wet and Above Normal water year types. These are monthly averages with limits on how much the 7-day running average may be below the monthly average. The SWRCB put the responsibility of meeting these requirements on the CVP and SWP. They share the responsibility as an in-basin use under the COA.	that NDOI may be. The COA is balanced monthly, if possible, with no owing carried over to the next month (need to double check this).
	Jun X2 reqts and the 3 ways to win. The Projects either cut exports or increase releases (up to caps specified in D1641) to freshen the water at the compliance points for the required number of days. How many days X2 needs to be at or west of a compliance station is a function of the previous month's Eight River Index.	Monismith monthly equation relating this month's X2 position to last month's position and this month's delta outflow. Now CalSim uses an ANN (to be discussed more below) to determine if NDOI is high enough for the 2 PPT (2.64 mmhos/cm) to be the required distance downstream (calculated as a weighted average of requirements at the three specified locations). If more NDOI is needed, CalSim will either curtail exports or increase releases to provide it.
X2)	theoretically, X2 will be required to be at or downstream of Chipps Island in Sep and Oct following W water years and at or downstream of Collinsville in Sep and Oct following AN water years. Novembers …	if NDOI is high enough for the 2 PPT (2.64 mmhos/cm) isohaline to be at or downstream of Chipps (W water years) or Collinsville (AN water years) for all the days of the month (Sep or Oct). Novembers …
Fish & Wildlife Beneficial Uses)	number of days six locations must have Chloride concentrations less than 150 mg/l as a function of yeartype. It also specifies those locations must always be fresher than 250 mg/l. Table 2 of D1641 lists several locations where the electrical conductivity must not exceed certain thresholds at certain times of the year for various water year types, generally using 14 day running average. Table 3 of D1641 lists a few more, generally using the maximum monthly average of daily high tide EC values.	level assumption, DWR has run DSM2 and QUAL. Using the flows and salinities and DCC operations from that run, DWR has trained an artificial neural network (I think of it as a super regression) to relate delta flow to salinity at key points in the delta where the most important D1641 standards exist. CalSim during its simulation of a month tells the ANN what delta inflows, exports, etc are planned to be and the ANN replies to CalSim if more flow is needed to meet the salinity standards. There is a different ANN for each SLR

		and restoration combination. (Section 7 simulations are using 6" SLR and 0 restoration combination ANN DLL)
	day period at an average rate of 6680 cfs. Between Dec15 and Mar15, SWP can additionally take 1/3 of Vernalis flow if Vernalis is flowing at or above 1000 cfs. CVP is allowed to export over a three day period at an average rate of 4600 cfs. Conveyance restrictions along the DMC before O'Neill often limit how much Tracy (Jones) can take, although the Intertie has helped boost CVP's ability to move water south somewhat. The SWRCB has allowed up to an additional 500 cfs at Banks to compensate for reduced pumping during the Apr-May timeframe. The water to be moved south during this period is water acquired through a Yuba River Accord. D1641 limits CVP+SWP exports to 100% of Vernalis or 1500 cfs (H&S), whichever is more, during the Apr15-May15 pulse flow period, given that VAMP has terminated.	capacities can occur indefinitely, i.e., no outages, etc. As an example, results will show Tracy pumping 4600 cfs for three summer months continuously. That hasn't happened in decades, if ever. This is in CalSim. This is in CalSim.
ratio)	specifies the maximum allowable CVP+SWP export rate as a function of San Joaquin River flow at Vernalis during Apr01-May31. The allowable ratio of Exports-to-Inflow varies by 60-20-20 yeartype thusly: W = 1:4 A = 1:4 B = 1:3 D = 1:2 C = 1:1 Hence it is more restrictive than D1641. Recall that this RPA Action was for a world without a NDD. The Vernalis flow augmentation component of Action 4.2.1 was	including the Section 7 No-Action Alternative.

	contingent on other actions evincing water from San Joaquin tributaries upstream of the Stanislaus. Those other actions have not occurred, yet. The Vernalis flow is the result of unaugmented flows from upstream of the Stanislaus combined with Appendix 2E flows on the Stanislaus* in Apr and May. * Upon occasion, Vernalis WQ or D1641 Vernalis flow reqts may drive the Stanislaus.	
Export Rate ('09 NMFS RPA - OMR)	specifies the maximum allowable CVP+SWP export rate as a function of combined Old and Middle River flow. Jan01-Jun15 OMR may not be more negative than -5000 cfs. Based on real time conditions, NMFS may change the constraint to be no more negative than -2500 cfs. (See RPA for more details.)	Old and Middle River flow constraints required in NMFS BiOp RPA are assumed to be covered by USFWS's BiOp RPA OMR flow constraints as modeled.
	<u>Action 1, Action 2, Component 2 and Component 3</u> specify the maximum allowable CVP+SWP export rate as a function of combined Old and Middle River flow. When the OMR constraint is imposed and to what extent (-5000 to -1250) depends on real time conditions. See RPA for more details.) In summary, the minimum allowable OMR constraint VERY generally runs from mid-Dec to Jun and ranges from -1250 to -5000.	are not input into CalSim, an attempt was made to represent the RPA's OMR provisions. The approach used, including caveats, is documented in "*Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies*", on February 10, 2010 (updated May 18, 2010). This (less the disclaimer) may be found in the BDCP DEIS Appendix 5A Section B10.

10) Specific Changes Comprising the Section 7 Proposed Action

a) Rio Vista minimum flow requirement of 3000 cfs for Jan01-Aug31 in addition to existing Rio Vista requirements.

b) OMR minimum allowable levels by month and yeartype in addition to existing OMR requirements.

All of the baseline model logic and input used in the No Action Alternative as a surrogate for the OMR criteria required by the various fish protection triggers (density, calendar, and flow based triggers) described in FWS and NMFS OCAP BOs were incorporated into the modeling of the Proposed Action, as well as these newly proposed operational criteria. Whenever those triggers require OMR be less negative or more positive than those shown below, the higher OMR requirements would be met. These newly proposed OMR criteria (and associated Head of Old River Barrier operations) are in response to expected changes under the Proposed Action, and only applicable after the proposed north Delta diversion becomes operational. Until the north Delta diversion becomes operational only the OMR criteria under the current BOs apply to CVP and SWP operations.

Combined Old and Middle River flows no less than values below[a] (cfs)
(Water year type classification based Sacramento River 40-30-30 index)

Month	W	AN	BN	D	C
Jan	0	-3500	-4000	-5000	-5000
Feb	0	-3500	-4000	-4000	-4000
Mar	0	0	-3500	-3500	-3000
Apr	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
May	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jun	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jul	N/A	N/A	N/A	N/A	N/A
Aug	N/A	N/A	N/A	N/A	N/A
Sep	N/A	N/A	N/A	N/A	N/A
Oct	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Nov	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Dec	-5000[d]	-5000[d]	-5000[d]	-5000[d]	-5000[d]

[a] Values are monthly averages for use in modeling. The model compares these minimum allowable OMR values to 2008 USFWS BiOp RPA OMR requirements and uses the less negative flow requirement.

[b] Based on San Joaquin inflow relationship to OMR. See the next page.

[c] - Two weeks before the D-1641 pulse, No OMR restrictions (modeling assumed -5000 cfs reqt)
- Two weeks during the D-1641 pulse (assumed to occur October 16-31 in the modeling), no south Delta exports
- Two weeks after the D-1641 pulse, -5,000 cfs OMR requirement (through November)

[d] OMR restriction of -5,000 cfs for Sacramento River winter-run Chinook salmon when North Delta initial pulse flows are triggered or OMR restriction of -2,000 cfs for delta smelt when triggered.

New, supplemental April OMR requirements:

If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (interpolated linearly between values)
≤ 5,000 cfs	-2,000 cfs
6,000 cfs	+1,000 cfs
10,000 cfs	+2,000 cfs
15,000 cfs	+3,000 cfs
≥30,000 cfs	+6,000 cfs

New, supplemental May OMR requirements:

If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (interpolated linearly between values)
≤ 5,000 cfs	-2,000 cfs
6,000 cfs	+1,000 cfs
10,000 cfs	+2,000 cfs
15,000 cfs	+3,000 cfs
≥30,000 cfs	+6,000 cfs

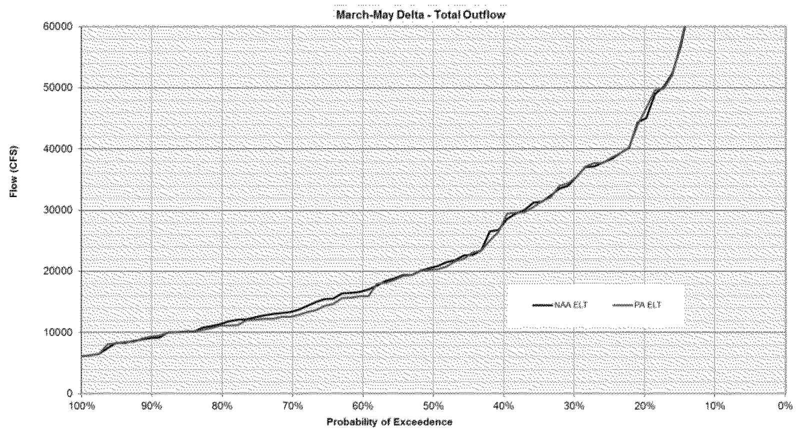
New, supplemental June OMR requirements:

If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (no interpolation)
≤ 3,500 cfs	-3,500 cfs
3,501 to 10,000 cfs	0 cfs
10,001 to 15,000 cfs	+1,000 cfs
>15,000 cfs	+2,000 cfs

c) Mar-May Avg NDOI requirement:

i) The objective was to keep the Longfin Smelt Index the same in the PA ELT as the NAA ELT. To do this, given what had been done in BDCP H4, the objective became for the PA ELT to match the NAA ELT's Mar-May average NDOI. The H4 approach of SWP semi-backstopping the higher springtime NDOI reqt fell out of favor. Ultimately, the PA was modeled assuming the SJ I:E ratio criteria applied to both South of Delta Exports and NDD exports. USBR and DWR have not committed to using that mechanism to achieve the goal of having NAA ELT level NDOIs to help assure the Longfin Smelt won't experience a degradation with the PA ELT.

ii)



d) New Head of Old River Barrier/Gate:

MONTH	HORB [a]
Oct	50% (except during the pulse)[b]
Nov	100% (except during the post-pulse period)[b]
Dec	100%
Jan	50% [c]
Feb	50%
Mar	50%
Apr	50%
May	50%
Jun 1-15	50%
Jun 16-30	100%
Jul	100%
Aug	100%
Sep	100%

[a] Percent of time the HORB is open. Agricultural barriers are in and operated consistent with current practices. HORB would be open 100% whenever flows are greater than 10,000 cfs at Vernalis.

[b] Head of Old River Barrier operation is triggered based upon State Water Board D-1641 pulse trigger. For modeling purposes the pulse was assumed to occur Oct16-Oct31.
Two weeks before the D-1641 pulse, it is assumed that the HORB will be open 50%.
During the D-1641 pulse, it is assumed the HORB will be closed.
Two weeks following the D-1641 pulse, it was assumed that the HORB will be open 50%
The exact timing of the action will be based on hydrologic conditions.

[c] The HORB becomes operational at 50% when salmon fry are migrating (based on real time monitoring). This generally occurs when flood flow releases are being made. For the purposes of

modeling, it was assumed that salmon fry are migrating starting on January 1.

In the CALSIM II modeling, the "HORB open percentage" specified above is modeled as the percent of time within a month that HORB is open. In the DSM2 modeling, HORB is assumed to operate such that the above-specified percent of "the flow that would have entered the Old River if the HORB were fully open", would enter the Old River.

d) North Delta Diversion: *** TO BE CONTINUED ****

Objective obj = {

[C1_EXC2,-3],   flow out of Trinity reservoir beyond power capacity is a little undesirable

[C3_EXC,-2010], flow beyond the MIF out of WSK is pretty undesirable

[C3_MIF,5500], highly desirable to maximize C3_MIF, but is constrained in code to prescribed amount

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```

Extra material:

a) LITERAL ANSWER: A “calsim model” is collection of files representing a scenario covering much of California using a monthly timestep.
   i) Four components of input
      (1) text tables | These house/
      (2) DSS files (Corps of Engineers Database) | comprise all
      (3) text files that comprise the run’s logic (DWR’s own programming language) | the input
      (4) a few compiled (external) functions like ANN | assumptions
   ii) Three components to execute the simulation
      (1) WRESL parser (DWR inhouse-developed compiler) to convert the input into a HUGE array of simultaneous equations each cycle of each month of each year simulated for processing by the solver
      (2) Optimization Solver – proprietary software that determines the best combination of storages and flows given the huge arrays of simultaneous equations (constraints and goals) and an objective function with weights and penalties.
      (3) GUI which ties it all together
   iii) Two components of output
      (1) DSS file containing all final variables’ values as well as some intermediate values.
      (2) Misc files mostly for investigating the solver’s process.